High Resolution Imaging of Biological Samples

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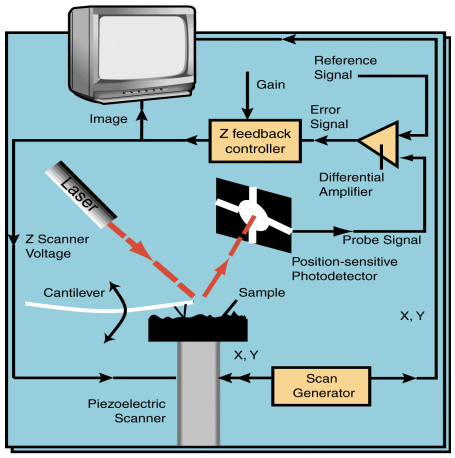
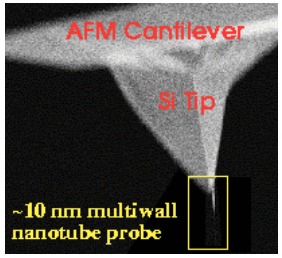
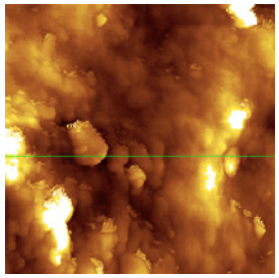
Atomic Force Microscope



The AFM probes the surface of a sample with a sharp tip located at the free end of a cantilever. Forces between the tip and sample surface cause the cantilever to bend or deflect. The deflection is measured by a detector to generate a map of surface topography.

The AFM's ability to create 3-D micrographs with Angstrom scale resolution finds applications from materials processing to cell biology.





Description

- Development of high resolution imaging capabilities to image biological samples using atomic force microscopy (AFM) by using single wall carbon nanotubes (SWNT) as the tips.
- Using SWNT, resolution would be increased from 50nm to sub-10nm and the tip is much more robust than silicon or silicon nitride.
- Two primary technical challenges
  - Instability of SWNTs in liquid is addressed using the recently developed magnetically driven oscillating probe (MAC mode AFM). MAC mode AFM utilizes lower amplitudes than conventional tapping-mode and improves SWNT stability in fluids.
  - Optimization (diameter, length, etc) of SWNTs attached to AFM cantilevers to obtain the desired high resolution (~1 nm). Chemical vapor deposition (CVD) enables the growth of SWNTs onto AFM cantilevers using a catalyst to initiate growth and a physical vapor deposition (PVD) procedure may eliminate some of the problems of CVD (tip movement, size changes, and aggregation).

Innovative Claims/NASA Significance

The imaging needs in NASA and NCI applications are : the ability to image down to the physical dimensions of a molecule of DNA and proteins in order to resolve the structure and correlate to their functions; imaging protein expression in cells; imaging cellular activities; not only structural resolution but high resolution functional imaging of biological structures. Many of the available techniques simply do not offer nanoscale resolution.

The current AFM technology which uses sub-50 nm tips provides decent resolution but not sub-10nm resolution. The brittleness of the tips results in rapid wearing or in extreme cases frequent breaking of the tips. The use of carbon nanotubes as tips is a promising alternative for both nanometer resolution and robustness.

Plans

- Optimization of tips for biological samples
- DNA imaging, tip stability issues to be addressed.
- Imaging of proteins
- Preliminary attempt to parallelize operation